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The Geology of Pingree SW Quadrangle Stutsman County, North Dakota

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THE GEOLOGY OF PINGREE SW QUADRANGLE

STUTSMAN COUNTY, NORTH DAKOTA.

by

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ABSTRACT

The glacial features fo the Pingree SW quadrangle were mapped in detail and studied carefully to relate their economic possibilities with the developement of the natural resources of the State of North Dakota. The glacial geology consists of a pronounced terminal moraine flanking the west of the quadrangle which was deposited by the latest Wisconsin ice sheet. Ground moraine covers three-fourths of the quadrangle and it's gentle rolling topography is contrasted by the deep preglacial valley of the Pipestem Creek and it's tributaries . The few recessional moraines present are subdued or of high relief and show a well defined pattern of ice movement. Gravel and sand deposits of commercial value are present in the river valley. Other deposits of sand and gravel but of secondary importance occur in the form of esker, kames, and outwash.

The Geology of Pingree SW Quadrangle

The Purpose of the Survey

The geology of the Pingree SW quadrangle and adjoining Elridge quadrangle was to mapped jointly by the writer and Ronald J. Kresl, during the field season of 1954. The North Dakota Geological Survey and United State Geological Survey are jointly making an intense studyof the ground water condition and natural resources of the State of North Dakota. A U.S.G.S. topography maps were used as a base maps in which reconnaissance by car gave us a general view of the area. Detail mapping was done on foot using shovel and auger for location of the glacial boundaries and to determine the composition of these different features.

Previous work in the area

Previous work in this area was undertaken by Danial E. Willard for the U.S.G.S in 1909. His report can be found in the Jamestown-Tower Folio.

Acknowledgements

During the course of this field work Doctor Gorden L. Bell was kind enough to help us in mapping the quadrangles and his advise and helpful criticism are appreciated. Acknowledgement to Doctor W. Laird for our employment and his supply of field equipment, also to my field associate Ronald J. Kresl.

General Description of the Area

The Pingree SW quadrangle, 98°52'39'' longtitude and 47°07'30'' latitude, is situated 2.4 miles west of Buchanan on U.S. highway 218 and 52. It is 2.9 miles south of the town of Pingree. In this area the topography takes on a most abrupt and irregular outline to the west. Steep stony hills closely packed, deep ponds at different levels within short distances, long, narrow and short hills give a wild aspect in comparison to the gently undulating slopes of the plain in the east and south-east.

The ground moraine which covers three-fourths of the quadrangle has an undulating somewhat pitted topography especially significant in the eastern part of the area. The greater part of the area is under cultivation and produces good yields of grains. The surface is well drained by many intermittent tributaries leading towards the Pipestem Creek. The valley of the Pipestem Creek is 75 to 100 feet deep and it appears to have been controlled by a preglacial channel because of its numerous kames terraces. This stream does not expose any bedrock in this quadrangle which is the Pierre shale in this region. But a few miles south where can be seen along the banks of the Pipestem valley.

The recessional moraines present are few and mostly subdued. These morainic hills were built in the recession of the last stage of glaciation and subsequently they were modified by meltwater and possibly overriden by the glacier. In mapping this area the contacts were outlined by the differences in topographic expression and a change in the lithology of the composition found in the glacial drift.

GEOLOGY

The surface mantle of the Pingree quadrangle is made up entirely of a thick glacial drift approximately 30 to 50 feet thick in the ground moraine and the terminal moraine has an average relief of about 25 to 50 feet . The bedrock is not exposed in this area althought fragments of the Pierre shale can be seen in road

cuts, gravel pits, and almost everywhere in the glacial drift close to the surface, indicating that the shale is underlying the drift close to the surface. This shale is gray to blue-black and where it is exposed in the adjacent areas it is weathered to a characteristic rectangular blocks or pencil-like fragments. Along the partings weathering of limonite concretions within the shale produces a yellowish brown stain.

The following is a geologic time table of the area:

Cenozoic Era
Pleistocene Epoch
Wisconsin age
Mankota subage
Gary subage

Mesozoic Era
Upper Cretaceous Period
Pierre fm.

Granitic rocks, dark basic intrusives, and quartzitic rocks of boulder size constitutes the major portion of the stony material. Althought small fragments of crystalline rocks make up the minute portion of the drift almost the entire body of the till is of local origin as it will be explained later.

The Mankota subage of the Wisconsin ice sheet composed of light brown to buff clay tills is the only drift found in the area, however remants of the Gary subage drift is present further south and south-west. (Willard)

TERMINAL MORAINE

The terminal moraine mapped in this area is part of the Hawk's Nest Moraine and is also a smaller section of the large Gary moraine. The moraine trends due south, thereby designating ablation to the east. A well defined steep ridge along the edge of the moraine in section 25, 36, T.142 N., R.65 W., indicates the accumulation of drift at the ice contact face of the glacier. This feature is a kame-like deposit where an overloaded glacial stream coming off the ice deposited the debris at the ice margin. The concentration of boulders in this area indicates that the ice sheet paused here for a considerable lenght of time due to climate changes

when the accumulation of snow was greater than the ablation.

The average relief of the knob and kettle tppography is about 25 feet and increasing westward to about 50 feet. The altitude at the base of the moraine is 1625 feet and rises to 1700 feet.

The most outstanding features throughout the terminal moraine are the kettle chaines. According to Twhaite, " kettle chainea are rather extensively long and narrow lakes arranged in rows ". These were formed by blocks of ice oriented north south and east-west , and because they were partially buried by drift, they are steep-sided with boulder lines situated above the water edge. The amount present day erosion of these youthful features is insignificant.

The till of the moraine is light buff to brown sandy clay with pebbles ranging from a few millimeters in diameter to many large erratics as lagre as three meters in diameter. Granitic rocks, gneisses and dark basic igneous rocks make up the large portion of the boulders. Cobbles and pebbles are mostly white to gray limestone, rounded to subrounded , with many small fragments of Pierre shale and some sand lens intermingled.

The color of the till indicates oxidation of the hematite and limonite concretions has taken place. These concretions come from the Pierre shale which occurs abundantly in the drift.The moraine is fairly well consolidated and somewhat impervious to surface waters due to the settling and compaction of the drift after the meltwater in the saturated moraine flowed out. All the kettle chaines were drained from at least two or more sides. Special care was taken in mapping this drainage to be consistent in choosing the altitude of the drainage level to indicate a well developed picture of theintense discharge when the ablation was at a maximum.

RECESSIONAL MORAINE

There are two types of recessional moraines in this quadrangle, the sublued type and those of high relief. The subdued type has been modified by meltwater or

average thickness from well data ranges from 25 to 50 feet, and becomes thinner farther south. This "subglacial" deposit is made up of fine grained, compact, aluminous clay with grains of quartz, particles of silt and angular crystalline rocks. The broad exposures of the ground moraine are buff, dark brown to black containning cobbles, pebbles and scattered boulders of various lithologic character. The presence of many small fragments of Pierre shale indicates that the bedrock is very close to the surface. According to Flint in Glacial Geology and the Pleistocene Epoch,"One fact is that glaciers carry very little rock material far beyond the places where it is picked up". Also, in the terminal zone of the ice, deposition is large, so that here much of the rock material becomes lodged in the ground very soon after it is picked up. In general, the ground moraine has an irregular crude bedding, unstratified compared to water deposited material, yet there are occasional small beds of stratified sands and gravels exposed in good road cuts.

SPILLWAYS

The Pipestem spillway system drains the central part of the Pingree SW quadrangle and flows south where it joins the James river at Jamestown. The average depth of the Pipestem valley is 45 feet which features a broad U-shape channel being slightly eroded by a relatively youthful creek. There are seven terraces in this large spillway which were formed by the following sequence of events: Before glaciation ocurred the valley was relatively broad and of mature age. The glacier covered this area and completely filled the valley with drift. Then meltwater from the terminal moraine flowing eastward the preglacial valley easiest to eroded and proceeded to re-exhumed this filled-in valley to it's present condition, leaving teraces as evidence of this feature.

In section 22, 21, 20, T.141N., R.65W., this spillway has pronounced terraces throughtout it's channel. It was thought that this could be part of a preglacial tributary to the Cannonball river which is beleived to have flowed east into the Pipestem river prior to glaciation. But upon further exploration of the terraces the termianl moraine made tracing of the terraces impossible. However, Doctor

possibly overriden by the receeding glacier.

The two recessional moraines which extend south-east from the terminal moraine in section 36, T. 142 N., R. 65 W., and section 7,8,17, T.142 N., R. 66 W., were greatly modified by meltwater from the terminal moraine and overriden by the last oscillation of the glacier at this point. There are few boulders present on this moraine. The average relief is about 40 to 50 feet in a gently rolling pattern associated with relatively flat ground moraine on the east side and spillways on the west side. These two moraines were deposited during the oscillation of the glacier when changes in the climate induced recession and readvacement of the glacier, and with the aid of meltwater modified these two moraines to their present conditions.

In section 10, 11, 15, T. 141 N., R. 65 W., are recessional moraines of the high relief type. These are steep-sided, 75 feet in height with many large boulders on the surface. The moraines are not bedrock controlled here but they show a somewhat lee and stoss topography. This feature indicates the direction of the receeding ice sheet to the north-east. The meltwater modified the stoss side leaving the lee side unchanged since this was the ice contact surface.

In section 14, 26, 23, 35, and 27, T. 142 N., R.65 W., thse moraines are associated with kettle chaines and spillways. At the time these moraines were deposited blocks of ice formed the kettles in chaines and the saturated drift poured fourth the meltwater into the spillways which modified the topography to the present relief. Settling and compaction also aided in the formation of these gently rolling recessional moraines.

GROUND MORAINE

Three-fourths of the deposits of he area are those of ground moraine. The average relief is approximately 10 feet, characterized by gently rolling surfaces. The gradient of this moraine is 20 feet per mile towards the Pipestem valley. The

Gordon Bell (personal communication) beleives that the preglacial Cannonball river joined thePipestem further north, near Woodworth.

The spillways are exceptionnally deep and straight in section 2, 3, 4, 11, 12, 13, T.142N., R66W., These channels give a clear picture of the tremendous amount of meltwater coming from the saturated terminal moraine and kettle chaines.

OUTWASH

A small deposit of outwash in section 14, 23, T.142 N., R. 65 W., on the edge of the terminal moraine fans out towards the Pipestem valley. On the north side of the outwash there is a well-defined terrace which is paved at the top containing boulders 2 to 4 feet in diameter. This terrace, typically called a boulder pavement, slopes towards the Pipestem and the size of the material becomes finer accordingly. The boulder are remnants of the erosion by the stream of all the fine material leaving the pavement of stones at its surface. The outwash deposits are excellent source for ground water. The water is generally low in dissolved minerals, but it may be hard especially where the wells approach the bedrock. Outwash deposits which are shallow, thick, and fine grained will yield a good flow of water at the water table. However, the water in the terminal moraine and sometimes in the ground moraine is not fit for domestic use because of the high alkaline content in the water. Outwash deposits are excellent source for sand and gravel for road construction. Although there is a wide range in size grades, screening will yield a high degree of uniform size which is adequate for local roads.

KAMES

In section 26, T.142 N., R.66W., the kame situated on the edge of the terminal moraine has a good road cut exposure of sand and gravel. The size of the material is exceptionally small and has a high content of Pierre shale. The high content of the shale in sand and gravel deposits is unfavorable for road construction.

Another kame in section 17, T.142 N., R.65 W., is situated in the channel of

the channel

the Pipestem Creek. There are no exposures on this kame, but a five-foot auger hole revealed a stratified deposit of sand and silt with a few pebbles.

The only esker is situatedin section 16, T.142 N., R.65 W. It is a narrow ridge, half a mile long and 25 feet in height. This esker was mapped on topographic expression alone. Because of lack of equipment the composition was not determined.

HISTORICAL SUMMARY

In Pliocene time, the relief ofthe area was more profound than it was during the Pleistocene Epoch. Many tributaries of the Preglacial Pipestem cut radidly into the soft beds of the Pierre shale and sculptured the land into hills and valleys.

The Mankota substage of the Wisconsin stage completelycovered this region in the last stage glaciation and extend south into known as the Dakota lobe. This ice sheet in it's recession formed the Gary and Altomont moraines in which the Hawk's Nest moraine discussed in this report is part of these moraines. The recession of the glacier was slowdue to the gradual climatic changes to warmer weather. Consequently, a tremendous amount of drift and blocks of ice were deposited to form kettle chains in this large terminal moraine.

In the Pingree SW quadrangle, the ablation increased considerably leaving only a few recessional moraines and these few moraines were modified by the large amount of meltwater coming from the ice front. As was previously mentioned, the preglacial Pipestem valley was broad and deep. During glaciation this valley was filled with drift and outwash. At the close of the Wisconsin stage, the spillways found this ancient channle easiest to erode and proceeded to re-exhume the Pipestem channel leaving terraces and outwash deposits along it's banks.

Finally, the continued ablation of the glacier to the east freed the area of ice sheet and spillways eroded the channels to their present condition. Modern drainage follows the spillways with relatively little down cutting.

Ground water conditions are very good in this area. Wells are dug in spillways and outwash deposits to about 20 or 50 feet where a good all year round supply of slightly mineralized water is obtained for domestic purposes. In the terminal moraine, the ground water is very mineralized due to poor circulation of the water. There is no flow of water obtained in this area unless a sand or gravel deposit is incountered. Wells situated in the ground moraine yield some ground water depending on the wet or dry seasons. In generally, the best water is obtained in the outwash deposits at the depth of about 10 to 40 feet. Usually the wells in the terminal moraine and ground moraine yield highly mineralized water causing excessive hardness and alkaline taste which is only good for stocks.

The best gravel and sand deposits for road construction are obtained in the outwash and kames deposits. However, there is a high content of Pierre shale in these gravel which is unfavorable for roads. Most of these deposits require screening because of the wide range of size grades.